MASTER OF SCIENCE
IN
PHYSICAL OCEANOGRAPHY

RIP CURRENT SPACING IN RELATION TO WAVE ENERGETICS AND DIRECTIONAL SPREADING

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Rip current spacings are compared with wave energetics and directional spreading in the Southern Monterey Bay. Southern Monterey Bay affords a unique environment to study rip currents, owing to their prevalence created by near-normally incident waves on a sandy shoreline. It is hypothesized that rip current spacing is a function of wave directional spreading and energy flux, based on the morphodynamic modeling by Reniers et al. 2003. A gradient of wave energy flux exists due to headlands and refraction over Monterey Canyon. Rip currents are shown to occur between cusps in the shoreline, allowing cusp spacing to be a surrogate for rip spacing. Rip current spacing was inferred from beach morphology surveys, LIDAR imagery, and Argus cameras, and found to be O(150m) at Sand City and O(300m) at Marina, separated by $\approx 6km$. Measured waves during a two month period using wave-rider buoys, show a gradient of across-shore energy flux between Sand City, $\overline{F}_x \cong 28000(J/m^2)$, and Marina, $\overline{F}_x \cong 33000(J/m^2)$. The two sites have the same peak directional spreading of energy value, $s_{peak} = 14^\circ$, and slightly different bulk values for Sand City, $s_{bulk} = 18^\circ$, and Marina, $s_{bulk} = 20^\circ$. Therefore, the variations in rip current spacing could not be attributed to directional spreading, but appear related to variations in energy flux.

KEYWORDS: Oceanography, Nearshore, Rip Currents, Directional Spreading, Beach Cusps, Coastal Video Imaging

THE FALL TRANSITION OFF CENTRAL CALIFORNIA IN 2002

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During the fall of 2002, the physical oceanographic conditions off Central California were monitored by means of CTD casts and VMADCP current measurements during two cruises. The first cruise, between Pioneer and Hoke Seamounts, included 38 stations and one time series station. The second cruise was sponsored by the Naval Oceanographic Office (NavO) and occupied nine sections along the coast from Pt. Reyes to just south of San Simeon. A total of 86 stations and two time series stations were occupied during the second cruise.

The isosteres, current vectors, and salinity distribution from the cruises provided a clear picture of the circulation pattern during the fall of 2002. A strong shoreward, anticyclonic meander of the California Current was observed along the offshore edge of the survey area. The meander advected Subarctic surface and intermediate waters into the region. Although the meander itself did not cross the dynamic trough that separated inshore and offshore currents, at the point where the meander was adjacent to the trough, a ridge formed which served to transport Subarctic waters into the coastal zone. These fresh waters then were

advected to the north and south along the coast, depending upon the direction of nearshore currents. The observed mesoscale circulation showed the manner in which waters which are upwelled at the coast in summer are replaced by oceanic waters in the fall and winter.

Analysis of the geography of the deep sound channel (DSC) during this period showed that the mean pressure of the DSC was at 586 dbar while the mean sound speed minimum was 1480 m/s. The minimum sound speed varied 3 m/s while the pressure of the minimum varied by 330 dbars. The shape of the pycnocline controlled the pressure and depth of the DSC in the region.

KEYWORDS: California Current System, Fall Transition, Deep Sound Channel

WAVE PROPAGATION OVER COMPLEX BATHYMETRY

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Swell propagates across thousands of kilometers of ocean in almost unchanged parallel wave fronts. Within the nearshore region however, refraction causes wave fronts to turn toward shallow depths, transforming the wave field. The Nearshore Canyon Experiment (NCEX) Pilot, conducted from October 10 to October 17, 2002, observed wave transformation across the Scripps and La Jolla canyon system near San Diego, California. Four Datawell Directional Waverider Buoys, three Nortek Vector PUV recorders, and two pressure sensors were deployed in depths ranging from 10 to 300 m. Observed energy density spectra and mean propagation directions were examined for three case studies representative of the range of observed swell conditions. Observations were compared to predictions of a back-refraction model provided by Dr. William O'Reilly. Observations indicate that refraction causes the waves to propagate along the deep axes of the Scripps and La Jolla canyons. At the shallow canyon heads, the convergence and divergence of ray trajectories cause extreme (2-3 orders of magnitude!) spatial variations in wave energy. Considering the complexity of the canyon environment, predictions of wave transformation agree surprisingly well with observations.

KEYWORDS: Refraction, Swell Transformation, Scripps Canyon

EFFECTS OF THERMOBARICITY ON COUPLED ICE-MIXED LAYER THERMODYNAMICS

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The unique properties of the temperature and salinity profiles for polar oceans are critical for high-latitude mixed layer thermodynamics. In the Polar regions, the water column is coldest and freshest at the surface where ice may be present. This density structure often leads to entrainment and affects both the mixed layer depth and the ice thickness.

Thermobaricity, the combined dependence of seawater thermal expansion on temperature and pressure, magnifies the buoyancy flux associated with mixed layer convection. When thermobaricity amplifies entrainment so that the heat into the mixed layer is greater than the heat leaving the water column, the mixed layer warms and any existing ice begins to melt. Similarly, if the heat entrained is less than the heat leaving the column, the mixed layer cools and freezing occurs at the surface. In the former situation a polynya, or region of no ice surrounded by ice coverage, may form.

A one-dimensional vertical model is built, and trial cases are run to show the intricate relationships that govern the heat and salt fluxes and subsequent ice thickness. The model shows the importance of thermobaricity to the air-sea-ice interactions. It also offers significant insight into how relatively constant atmospheric forcing can lead to polynya-like conditions.

KEYWORDS: Mixed Layer, Thermobaricity, Entrainment, Polynya

THE BOTTOM BOUNDARY LAYER UNDER SHOALING INNER SHELF SOLITONS

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The effects of shoaling inner shelf solitons on the bottom boundary layer have been observed and analyzed over a two month summer period at the Monterey Inner Shelf Observatory in Monterey, California, during 2002. Utilizing CTD data to characterize the temperature field of the water column, Acoustic Doppler Current Profiler (ADCP) data to measure the velocity structure from 3m height above the bed (HAB) to the near surface, and Bistatic Doppler Velocity Sediment Profiler (BDVSP) data to measure the velocity structure and sediment concentration from a range of 60cm to 1cm HAB, solitary internal waves and internal tidal bores were regularly observed at the observation site. These events were characterized by their large isotherm displacements and the sudden change from near surface to near bed stratification as the internal tidal bores passed the observation site. Cross-shore timeseries revealed that the strongest events pushed water onshore near the surface and offshore near the bed, indicating a baroclinic water column during their passage. To analyze their effects on the bottom boundary layer, 3m HAB ADCP and BCDV velocities were compared with backscatter data and surface gravity wave energy at 3m HAB to determine their relative contribution to bed stress and resulting sediment suspension. As the strong internal waves passed, a logarithmic layer formed indicating that shear stress above the bed was occurring. This allowed the friction velocity within the log layer to be estimated. Combining this term with the stress contribution due to the wave energy, the total stress on the bed was then estimated. From this it was determined that typically moderate surface gravity wave forcing at the bed suspended sediment, while solitary internal waves and internal tidal bores continued to transport suspended sediment offshore near the bed.

KEYWORDS: Oceanography, Nearshore, Waves, Currents, Tides, Internal Tidal Bores, Solitons, Sediment Suspension, Sediment Transport